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RLC Window Size Reconfiguration

FIELD OF THE INVENTION

The present invention relates to RLC window size reconfiguration in Wideband Code Division Multiple Access (W-CDMA) standard as defined by 3GPP.

BACKGROUND OF THE INVENTION

RRC signalling currently support reconfiguration of RLC parameters during a connection, e.g. with a RADIO BEARER RECONFIGURATION message. However, the actions related to a reconfiguration, particularly a reduction of the RLC window size, are not explicitly specified in the document 3GPP TS 25.322. The following will highlight why the reconfiguration of the RLC window size is highly beneficial.

Consider a UE with UE reference class 384 kbps. According to the document 3GPP TS 25.306, typical RLC capabilities for this UE class is 50 Kbyte UE memory and maximum 6 AM RLC entities. Thus, the UE can potentially use 3 parallel PS RABs. The focus of the following discussion will be the case with 2 simultaneous PS RABs, e.g. 2 parallel interactive RABs or one interactive and one streaming RAB.

When the first PS RAB is setup, UTRAN can not know if a second (or third) PS RAB will be setup in the future. As the RLC window size of the first PS RAB can not be reduced when a subsequent RAB is setup, UTRAN need to take into account the memory usage of RABs that may potentially be setup in the future. To allow, e.g., 2 parallel PS RABs, UTRAN can only allocate half of the available UE memory for the first PS RAB, which leads to a reduced performance.

Assuming, e.g., that the window size for SRB2-4 has been configured to 128, which is the only choice with default configurations if the UE has made handover from GSM. If the RLC window size could be reduced at reconfiguration, UTRAN could now allocate the whole remaining memory for the first PS RAB, e.g. a window size 512 in downlink and 256 in uplink, resulting in a total memory usage of 42 kbyte. If a second PS RAB is later setup the window sizes could be reconfigured to suit the number of simultaneous RABs. However, since the potential memory usage of a second PS RAB needs to be considered already when the first PS RAB is setup, the RLC memory can only be configured to, e.g., 256 in downlink and 128 in uplink, which results in a worse performance.

Especially for higher data rates, e.g. 384 kbps, the RLC window size has a significant impact on the performance in terms of delay/throughput. Since 2 parallel PS RABs may only be used in a fraction of the PS connections this implies that a large amount of the UE memory is unused for most UEs and the throughput for PS connections unnecessarily low. If 3 parallel PS RABs are considered, the problem is even more severe, since UTRAN can only allocate one third of the available UE memory when setting up the first PS RAB.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an example of an RLC window size reduction. The grey PDUs are transmitted/ received and the white PDUs are not yet transmitted/ received.

DESCRIPTION OF THE INVENTION

The present invention refers to methods for reconfiguring the RLC window size. Since the reconfiguration of RLC window size is supported according to the document 3GPP TS 25.331 and the modelled RLC interaction with higher layers allows for a reconfiguration of any RLC parameter it can be argued that both increase and decrease of the configured RLC window size is already supported in R99. However, in particular when the window size is decreased the UE actions are not unambiguous. It is therefore proposed to clarify the actions related to a decrease of the window size as described below. Note that an AM RLC entity has both a transmitting and a receiving side, i.e. both the receiver and transmitter behaviour is applicable for the UE.

In Figure 1 an example of a window size reconfiguration is shown where the window size is reduced from 16 to 8. In case a) the transmitter and receiver windows cover the same sequence number range and in case b) the receiver window is advanced further than the transmitter window due to that a status message acknowledging PDUs 0 and 1 has not yet been sent, or has been sent but lost over the air interface.

The following will now describe a first embodiment of the solution according to the present invention:

Reduction of the receiver window: When the receiver window is reduced, some of the PDUs received in the old receiver window may end up being outside the new receiver window. In order to free memory it is proposed that these PDUs shall be discarded in the UE and treated as not being received. This implies that UTRAN needs to retransmit these PDUs after the reconfiguration but this is considered to have little impact on the performance.

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Reduction of the transmitter window: When the transmitter window is decreased, some of the PDUs transmitted in the old transmitter window may end up being outside the new transmitter window. The first solution that comes to mind is to discard these PDUs from the transmitter in order to free memory. However this may imply the following consequences:

1) Permanent data loss: If these PDUs are discarded, they can not be retransmitted which would lead to a permanent data loss. This could potentially be acceptable for RBs but would mean that it is not possible to reduce the window size for SRBs. As discussed in relation to the default configurations used at handover from GSM it would be beneficial to be able to reduce the window size from the value 128 used in the default configuration to a lower value to free memory.

2) Errors in protocol operation: The discarding of PDUs in the transmitter may lead to protocol errors. Consider case b) in Figure 1 above. If the transmitter would discard PDUs outside the new transmitter window it means that PDUs 8-15 are discarded and can not be retransmitted. However, due to that the receiver window in case b) is advanced further than the transmitter window, a PDU with SN=8 is within the new receiver window. If this PDU can not be retransmitted the RLC protocol has stalled.

It is therefore proposed that all PDUs that are not positively acknowledged are kept in the buffer. This implies that if UTRAN negatively acknowledges some of the PDUs 8-15 in the example after the reconfiguration, the UE must be prepared to retransmit the PDUs.

This solution implies that the RLC buffer memory required for the reconfigured RLC entity momentarily can be as high

as the old RLC window indicates. This could potentially mean that there is not enough free memory to segment all incoming SDUs for all RLC entities. It is therefore proposed to specify that if the memory capability of the UE is exceeded, the UE does not need to segment SDUs received from upper layers. This means that the memory required for all transmitter buffers in the UE will not require more memory than needed to support the configured RLC windows at any time.

The interaction between RLC and higher layers when data can not be transmitted (e.g. due to that the RLC window is full or the RLC entity is suspended) is not specified. However, some form of flow control must exist also in, e.g., existing R99 UE implementations to prohibit a higher layer application to submit data to RLC in these situations.

The first embodiment is rather straightforward but might not work well if the in-sequence delivery is not configured. If for example an SDU is present in PDUs 11-12 in case b) this SDU may already be delivered to higher layer when the reduction of the RLC window size occurs. After the reconfiguration these PDUs will be retransmitted by the peer entity and consequently a duplicate of the SDU will be delivered to higher layers. The retransmission of PDUs with sequence numbers outside the old transmitter window also cause additional delay.

Therefore, as a second embodiment of the present invention, a more advanced window handling can be specified as described below:

Reduction of the receiver window: When the receiver window is reduced, all PDUs in the receiver buffer are kept, even if these PDUs are outside the new receiver window. The

receiver window is advanced according to the normal rules described in 3GPP TS 25.322.

Reduction of the transmitter window: When the transmitter window is reduced, all PDUs in the transmitter buffer are kept, even if these PDUs are outside the new transmitter window. The transmitter window is advanced according to the normal rules described in 3GPP TS 25.322.

Memory handling: Since all PDUs are kept in the RLC buffers at reconfiguration, it is possible that PDUs transmitted and/or received on the new RAB temporarily causes the UE RLC buffer capability to be exceeded. To handle the possibility that the UE buffer memory may not be sufficient to handle all AMD PDUs during an initial time after the reconfiguration, the following behaviour is proposed:

Before a SDU received from upper layers is processed or a received AMD PDU is stored, the UE must check that the RLC buffer memory is sufficient to store the following PDUs:

In the receiver side: AMD PDUs with SN in the interval [VR(R)< SN< VR(H)] for all RLC AM entities

In the transmitter side: AMD PDUs with SN in the interval [VT(A)< SN< VT(S)] for all RLC AM entities

If the processing of a SDU received from upper layer leads to over-allocation of the UE buffer memory according to the signalled UE capability, the SDU shall not be processed.

If the reception of an AMD PDU leads to over-allocation of the UE buffer memory according to the signalled UE capability, the PDU shall be ignored. This check only needs

to be performed if the SN of the received PDU causes VR(H) to be increased.

In this way it is guaranteed that a UE always can receive AMD PDUs with SN in the interval [VR(R)< SN< VR(H)] for all RLC AM entities (i.e. retransmissions), which is needed to prevent potential deadlock situations. If this is not guaranteed it is possible that the UE ignores all received PDUs and it is not possible to get out of the stall situation.

Two embodiments for handling the reduction of the configured RLC window size has been described. The first embodiment is straightforward but only works if the in-sequence delivery is configured. This embodiment also requires that the PDUs outside the new RLC window are retransmitted after the reconfiguration which implies a larger delay for the user data. The second embodiment requires more advanced memory handling but handles also the case where in-sequence delivery is not configured and avoids retransmissions of PDUs after the reconfiguration.

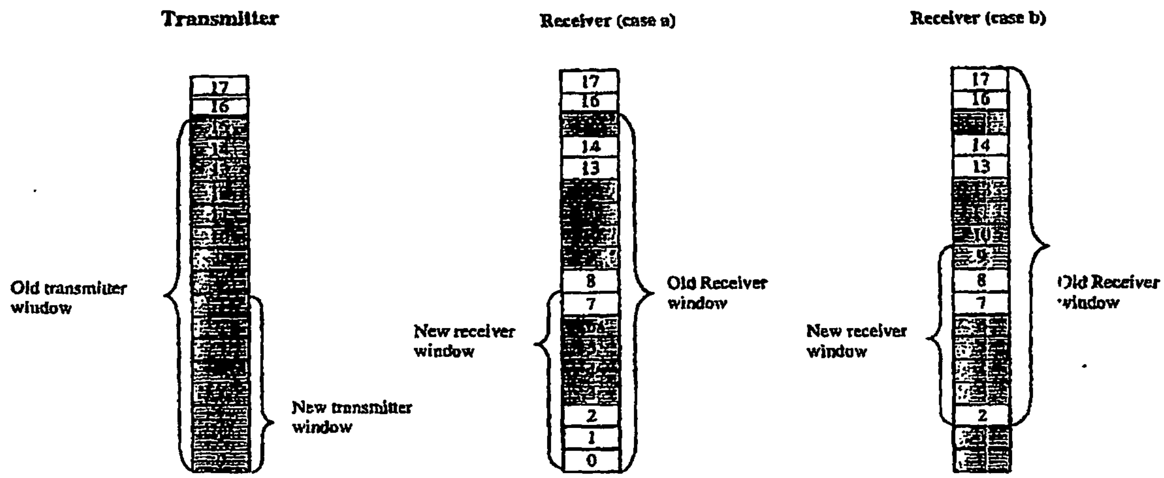

Figure 1

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